

AMENDMENTS TO THE SPECIFICATION

Page 2, first full paragraph:

-- Among the conventional a-c motor-generators capable of developing high-power output, there is a motor-generator disclosed in Japanese Patent Laid-Open No. 236260/1995, which is co-pending application of the present inventor. The prior motor-generator controls magnetic flux density in proportion to the speed in revolutions per minute (rpm) of the rotor to adjust properly an amount of the generated amperes or voltages. To cope with this, a control ring is arranged between the rotor and the stator for rotation relatively of them and further a magnetic flux permeable member is provided in the control ring.--

Paragraph spanning pages 2 and 3:

-- Further disclosed in Japanese Patent Laid-Open No. 261988/2000, which is also co-pending application of the present inventor, is a motor-generator in which a cylindrical controller member is arranged on the inside surface of the stator, the cylindrical controller member being formed of magnetic permeable pieces and non-permeable pieces, which alternate in position circularly in the form of a cylinder. The cylindrical controller member is moved selectively to any angular position relatively to the stator in accordance with

an operating phase of the motor-generator. That is to say, to get it started, the cylindrical controller member is moved to an angular position where the magnetic flux permeable pieces of the controller member are brought into radial alignment with the teeth of the stator, each to each tooth. In contrast, when the rotor comes to rest, the cylindrical controller member is moved to another angular position where the magnetic flux permeable pieces may be cooperative with the teeth of the stator core to provide the magnetic path around the overall circumference of the controller member, thus allowing the magnetic flux to pass circumferentially of the controller member with a uniform distribution, thereby ensuring smooth rotation of the rotor.--

Paragraph spanning pages 3 and 4:

--In conventional motor-generators, there is a way in which the on-off switch operation of a power transistor chops the generated power to produce a chopped voltage. However, this way has a major problem of causing a high ripple voltage, which makes it tough to control the generated power. With the prior motor-generator disclosed in the senior application stated earlier, there is provided an annular member composed of magnetic flux permeable pieces arranged circularly at a pitch equal to a stator tooth pitch, with resinous pieces being each interposed between any adjoining

magnetic flux permeable pieces so as to match the stator slots. The annular member is installed around the rotor for angular movement relatively to the stator. At low speed in rpm the annular member is moved to an angular position where the magnetic flux permeable pieces come in radial alignment with the stator teeth. In contrast, when the rotor is driven at a high speed, the annular member is shifted to another angular position where the magnetic flux permeable pieces are each displaced out of the alignment with the associated stator tooth to reduce an area allowing the magnetic flux to pass through there. With the construction in which the magnetic flux permeable pieces are arranged intermittently and jointed together with resinous pieces to form a cylinder, the resinous pieces are much subjected to wear during revolution of the rotor. Moreover, the annular member, since being subject to restoring force, experiences a large force rendering magnetism much more when the magnetic path is reduced. This makes a troublesome problem of causing deformation of the annular member, which might lead to breakage of the annular member.--

Page 7, first full paragraph:

-- A prior approach to the resolution of the problem as stated just above is the permanent-magnet generator disclosed in Japanese Patent Laid-Open No. 261988/2000 recited earlier. With the prior generator, since the magnetic flux

permeable pieces are arranged intermittently and jointed together with resinous pieces to form the annular member, the resinous pieces are much subjected to wear during revolution of the rotor. Moreover, the annular member, since being subject to restoring force, experiences a large force rendering magnetism much more when the magnetic path is reduced. This makes a troublesome problem of causing deformation of the annular member, which might lead to breakage of the annular member.--

Paragraph spanning pages 7 and 8:

-- Another problem faced in the motor-generator resides in the magnetic path, more particular, the air gap between the rotor and the stator. The permeability of air is  $4\pi \times 10^{-7}$  (H $\square$ m), whereas the permeability of silicon steel containing 3%Si is thirty thousand times that of air and the permeability of PC nickel-iron alloys is fifty thousand times that of air. That is, both the alloys have extraordinary high magnetic permeability as compared with air. It will be thus appreciated that any cylindrical member for controlling magnetic flux, arranged around the outside periphery of the rotor for angular movement relatively to the stator with keeping either close contact with or any infinitesimal clearance spaced apart from the tooth tips of stator teeth, may help ensure a magnetic path well in efficiency of the

motor-generator. Nevertheless, the cylindrical member recited just above, as constructed in a structure that magnetic flux permeable pieces and nonmagnetic pieces alternate circularly with each other, has a disadvantage that the magnetic flux density is too restricted at an area where any magnetic flux permeable piece intersects any nonmagnetic piece, thereby rendering the magnetic field entering the stator too small.--

Paragraph spanning pages 8 and 9:

--Even if it were allowed, in light to air less in permeability, to form the stator itself in a construction making it possible to restrict the flow of flux passing through the stator core, the magnetic flux density passing through the stator would be well controlled with no provision of the conventional magnetic-flux control means such as the cylindrical member for control of the magnetic flux, which is composed of the magnetic flux permeable pieces combined with the nonmagnetic pieces and arranged between the stator and the rotor revolving at high speed in rpm. This concept to form the stator itself in a construction making it possible to restrict the flux passing through the stator core posses no problem of encountering wear of the magnetic flux permeable and nonmagnetic pieces in the cylindrical member for control of the magnetic flux and also occurrence of accidental collision of the cylindrical member with the revolving rotor.

Moreover, there is no fear of cracking and/or breakage at an interface between any adjacent magnetic flux permeable and nonmagnetic pieces, which might occur due to difference in linear expansion coefficient, hardness and so on between materials of the magnetic flux permeable and nonmagnetic pieces.--

Page 10, first full paragraph:

-- However, even the motor-generator having the magnetic flux permeable member made extremely small in area contains still a drawback to be resolved, in which it does not control positively the inferior permeability, or nonmagnetic property of air. Moreover, as opposed to the motor-generator of the type having the generation characteristics in which the voltage rises in proportion to the increase of rpm, the motor-generator of the type stated earlier will be reduced in the rate of voltage rise. Nevertheless, the decrease in the rate of voltage rise is too slow to always meet the desired characteristics.--

Page 11, first full paragraph:

--With the magnetic flux control means according to the present, moreover, there is provided an annular member of a simple construction in which magnetic permeable pieces and nonmagnetic pieces are arranged alternately to form a cylinder

and joined together to ensure steady mechanical strength of the annular member, the magnetic flux permeable pieces being chamfered at corners on a radially outside circumference of the annular member. The annular member may be moved angularly in a steady sliding manner in response to the variation in rpm to control properly the magnetic flux, thereby ensuring always the desired constant voltage.--

Page 13, first full paragraph:

-- In an aspect of the present invention, a magnetic flux control means for a motor-generator is disclosed, in which the annular member is arranged inside the stator and comprised of a magnetic flux permeable piece less in width than the slot defined between any two adjacent teeth in the stator core, and a nonmagnetic piece interposed between any two adjacent magnetic flux permeable pieces, and in which the windings laid in the stator are composed of a high-tension winding of more than one winding set for a power source, a low-tension winding of more than one winding set and a voltage-variable winding of at least one winding set for voltage control while the controller serves for controlling on-off operation of a switching means to change over connections among the winding sets, thereby varying a number of turns of the high-tension winding and the low-tension winding.--

Page 14, first full paragraph:

--In another aspect of the present invention, a magnetic flux control means is disclosed, in which the controller energizes the driving means to move circumferentially the annular member between an angular position where any clearance between any magnetic flux permeable piece in the annular member and the opposing tooth in the stator is made reduced so that the magnetic flux is unrestricted and another angular position where the clearance is made large so as to restrict the magnetic flux to thereby lower an output voltage.--

Page 16, first full paragraph:

--In another aspect of the present invention, a magnetic flux control means is disclosed, in which the annular member is comprised of magnetic flux permeable pieces each of which is formed in a rectangular shape in cross section having a width less than that of the slot between any two adjacent teeth in the stator, the magnetic flux permeable pieces being arranged in juxtaposition along an inside periphery of the stator with nonmagnetic pieces being each interposed between any two magnetic flux permeable pieces, and the permeable pieces are each chamfered off at corners on a radially outside circumference of the rectangular shape in cross section to provide first chamfered areas, so that when any magnetic flux

permeable piece is placed in opposition to any slot in the stator, first clearances of preselected amount are left between the first chamfered areas and widthwise opposing corners of the associated teeth on a radially inside circumference of the stator.--

Paragraph spanning pages 21 and 22:

-- In another aspect of the present invention, a magnetic flux control means is disclosed, in which the annular member is arranged inside the stator and is comprised of density-rich magnetic flux permeable parts in which magnetic flux permeable materials are closely laminated in the form of a circle, and density-lean magnetic flux permeable parts in which magnetic flux permeable chips are arranged circularly in a manner spaced apart from each other at an interval of circumferential length equivalent to a circumferential width of the tooth and nonmagnetic chips are each arranged in a space left open between any two adjacent magnetic flux permeable chips, the nonmagnetic chips being made of nonmagnetic reinforcing material such as aluminum and so on, and the density-rich and density-lean magnetic flux permeable parts unlike in density being arranged alternately along the axial direction.--

Page 22, first full paragraph:

--In another aspect of the present invention, a magnetic flux control means is disclosed, in which the magnetic flux permeable chips are arranged circularly in such a way to leave a space open between any two adjacent magnetic flux permeable chips, the space being equal in number to the teeth and provided at an interval of length equivalent to a circumferential width of the tooth in the stator. Moreover, both the density-rich magnetic flux permeable parts and the magnetic flux permeable chips are made of circular magnetic flux permeable plates laminated densely at an equal interval.-

Paragraph spanning pages 22 and 23:

-- In another aspect of the present invention, a magnetic flux control means is disclosed, in which the density-lean parts of the annular member are each composed of annular magnetic flux permeable steel plates overlaid axially one on the other, the annular magnetic flux permeable steel plate being made of arched density-lean chips and density-rich chips, which are arranged in the form of cylinder in a manner spaced apart at an equal interval, and windows left open between chips unlike in density are filled with the nonmagnetic reinforcing material.--

First paragraph at page 23:

-- In a further another aspect of the present invention, a magnetic flux control means is disclosed, in which the density-rich parts of the annular member are each made of an axial lamination of a magnetic flux permeable ring and a silicon-steel plate, which are jointed together.--

Page 24, second full paragraph:

-- In a further aspect of the present invention, a magnetic flux control means is disclosed, in which the nonmagnetic piece is either replaced with air or made of any reinforcing member of aluminum, resinous material and so on. Moreover, the annular member is made of an axial lamination of more than one ring member in which the magnetic flux permeable piece and the nonmagnetic piece are overlaid one on the other.--

Paragraph spanning pages 26 and 27:

-- In the motor-generator of the present invention, the nonmagnetic pieces of aluminum or aluminum alloys charged by casting or the like between any two adjacent magnetic flux permeable pieces contribute to the improvement of stiffness in the annular member, which controls effectively the magnetic flux, depending on the revolving conditions of the rotor. Thus, the annular member may resist well against the reaction

with the result of the improvement in durability. Accordingly, the present magnetic flux control means for the motor-generator will be suitable for use in, for example high-speed generators and motors for the conversion of mechanical energy into electrical energy or, conversely, electrical energy into mechanical energy, power supply sources for energizing refrigerators or coolers mounted on vehicles, electric power sources to energize a heater in the diesel particulate filters, generators combined in cogeneration system, electric rotating machinery coupled with the automotive engine in a hybrid vehicle, and high-speed motors operating machines such as machine tools. It is to be noted that the motor-generator with the magnetic flux control means of the present invention tolerates well the high speed of, for example 60,000rpm, and is made slim in construction with even less production costs.

Paragraph spanning pages 27 and 28:

-- With the magnetic flux control means constructed as stated earlier, the magnetic flux permeable pieces in the annular member is made smaller in circumferential width than the slot defined between any two adjacent teeth in the stator, while chamfered off at the surface opposing the teeth tips in the stator. The construction results in providing the clearance for magnetic path between the annular member and the

stator teeth, which is most suitable for proper voltage control.--

Page 29, first full paragraph:

--In the magnetic flux control means of the present invention, moreover, there is provided the annular member containing a skeletal structure of magnetic flux permeable pieces chamfered at their circumferentially opposing corners on the radially-outside curved surface, and nonmagnetic pieces of aluminum and so on less in relative permeability poured by casting in the spaces between any adjacent magnetic flux permeable pieces to surround around each the magnetic flux permeable pieces, including their chamfered tips. Thus, the magnetic flux control means of the present invention is not only improved in electromagnetic property, but also made steady in mechanical stiffness so as to be able to stand up certainly the reaction.--

Paragraph spanning pages 29 and 30:

-- When the rpm of the rotor starts to go too higher, the annular member high in stiffness is moved circumferentially to any angular position where any magnetic flux permeable piece is offset circumferentially out of the radial alignment with the associated tooth in the stator, so that the magnetic flux passing through the teeth will be

restricted to make the produced power less in voltage. To cope with such event that a simple movement of the annular member is insufficient to restrict the magnetic flux to the extent where the developed power at high speed in rpm of the rotor may be lowered to a desirable voltage, the windings laid in the slots in the stator are made to be varied in a number of turns. That is to say, the windings are grouped into more than one winding set that may be changed in connection among them. Thus, the winding sets at low speed in rpm of the rotor are connected in series to increase the number of turns, whereas at high speed connected in parallel or left alone to reduce the number of turns. This allows regulating the developed power to give a preselected desirable voltage, thus makes it possible to easily produce a constant d-c voltage of, for example 100V for automotive auxiliaries, especially would make easy to give a constant voltage in the three-phase generators.--

Paragraph spanning pages 30 and 31:

-- In the magnetic flux control means of the present invention, there is provided an annular member that density-rich magnetic flux permeable pieces are arranged circularly in a continual manner so that the part subjected to wear continues around the overall periphery. This arrangement allows reducing uneven wear to the minimum, thereby not only

making the steady sliding revolution possible but also realizing strength retention of the annular member itself. According to the magnetic flux control means having the annular member in which the magnetic flux permeable pieces are chamfered at their widthwise opposing corners, the clearance defined between the annular member and any tooth in the stator may be reduced to an extent of 0.05~0.1mm, while the clearance between the annular member and the rotor will be reduced to an extent of 0.5~0.1mm, so that the loss in magnetic path may be much reduced. Moreover, this allows keeping the clearance between the annular member and the rotor minimum and correspondingly raising efficiency.--

Paragraph spanning pages 34 and 35:

-- As a further alternative, there is provided a magnetic flux control means having the annular member, which is comprised of density-rich magnetic flux permeable parts in which magnetic flux permeable materials are closely laminated in the form of a circle, and density-lean magnetic flux permeable parts in which magnetic flux permeable chips are arranged circularly in a manner spaced apart from each other at an interval of circumferential length equivalent to a circumferential width of the tooth and nonmagnetic chips are each arranged in a space left open between any two adjacent magnetic flux permeable chips, the nonmagnetic chips being

made of nonmagnetic reinforcing material such as aluminum and so on, and the density-rich and density-lean magnetic flux permeable parts unlike in density being arranged alternately along the axial direction. With the magnetic flux control means constructed as stated just above, the magnetic flux will have nowhere to pass in an event where any magnetic flux permeable chip is placed out of the teeth in the stator, so that the rotor should not be able to revolve with smoothness. But the presence of the density-rich parts, although restricting the magnetic flux, helps ensure the smooth rotation of the rotor. Moreover, the annular member is apt to experiences a reaction that is caused by bending the magnetic path when the magnetic flux is restricted. To cope with this, the nonmagnetic chips are made of reinforcing materials such as aluminum and so on, instead of resinous material, thus resisting well against the reaction. The density-rich part in the annular member, since made of a circular continuity, not only contributes to increasing strength of the annular member, but also makes the surface sliding over the stator smooth, thereby keeping the uneven wear minimum. This helps always ensure the steady angular movement of the annular member. In other words, the stator is made circumferentially discontinuous between the slots and the teeth alternating circularly, whereas the annular member has some continuities

of density-rich magnetic flux permeable part, arranged axially in a manner spaced apart from each other at an axial interval. This allows the annular member to move circumferentially with smoothness.--

Paragraph spanning pages 46 and 47:

-- The rotor 3 is composed of a magnetic path 6 arranged around the rotor shaft 2, a magnetically permeable member 8 arranged over the outside periphery of the cylindrical magnetic path 8, a permanent-magnet member 5 made of more than one permanent-magnet piece 35 extended axially and arranged circumferentially over the outside periphery of the magnetic permeable member 8 with nonmagnetic pieces 21 being each interposed between any two adjoining permanent-magnet pieces 35, and a nonmagnetic reinforcing member 16 secured over the outside periphery of the permanent-magnet member 5. The magnetic path 6 is composed of more than one magnetic flux permeable pieces and nonmagnetic pieces, which are arranged to form a cylinder in a manner they alternate each other circularly around rotor shaft 2. The rotor 3 is clamped between axially opposite retainer plate 26 and backing plate 22, which are abutted against axially opposing ends of the rotor 3, each to each end, and kept on the rotor shaft 2 against rotation by tightening a fixing nut 38 on an externally threaded end 36 of the rotor shaft 2. A motor-

generator pulley, although not shown, fixed to any one end of rotor shaft 2 is connected through a belt to an output shaft of an engine. The annular member 7 is arranged around the rotor 3 to form an annular clearance 23 between them.--

Paragraph spanning pages 47 and 48:

-- The magnetic flux control means of the present invention, as shown in FIGS. 4 to 6, has the annular member 7 arranged inside the stator 4 for angular movement with keeping sliding contact with the inside surface of the stator 4, and an actuator 9 to move circumferentially the annular member 7 through a rod 31 connected to the annular member 7. The annular member 7 is composed of more than one magnetic flux permeable piece 17 arranged circumferentially in a way spaced apart from each other with nonmagnetic pieces 18 being each interposed between any two adjoining magnetic flux permeable pieces 17. As seen from FIGS. 6(I) and 6(II) explaining positional relation between the stator core 15 and the annular member 7, the magnetic flux permeable piece 17 of the annular member 7 is made somewhat less in circumferential width than the tooth 20 of the stator core 15. A controller 10 is to govern the rotating movement of the annular member 7 to vary an overlap area between the confronting magnetic flux permeable piece 17 and tooth 20, thereby controlling the degree to which the magnetic flux is restricted.--

Paragraph spanning pages 48 and 49:

-- With the annular member 7 in which the magnetic flux permeable pieces 17 are arranged in the form of cylinder with the nonmagnetic pieces 18 being each interposed between any two adjoining magnetic flux permeable pieces 17, the magnetic flux permeable piece 17, as shown in FIGS. 6(I) and 6(II), is made less in circumferential width than either the tooth 20 or the slot 20 of the stator 4. Although not shown in detail, the nonmagnetic piece 18 may be either replaced with air or made of any one of aluminum, resinous material and so on. The annular member 7, although not shown, may be constructed with annular discs laminated axially, each of which is composed of magnetic flux permeable pieces 17 and nonmagnetic pieces 18 alternating each other circularly. In this alternative, the nonmagnetic piece 18 may be either replaced with air or made of any one of aluminum, resinous material and so on. Each magnetic flux permeable piece 17 is less in circumferential width than the tooth 20. But the number of the magnetic flux permeable pieces 17 is set equal to the number of the teeth 20. As an alternative, the annular member 7 may be built up of laminations juxtaposed axially, each of which is made of an annular disc of the magnetic flux permeable piece 17 and a silicon steel sheet laid one on top of another.--

Paragraph spanning pages 50 and 51:

-- The controller 10 will energize the actuator 9 to rotate the annular member 7 to any angular position where a clearance between any magnetic flux permeable piece 17 of the annular member 7 and the associated tooth 20 of the stator 4 is made small so that the magnetic flux is less subject to restriction. In contrast, when the annular member 7 is moved to another angular position where the clearance is made large, the magnetic flux is much restricted to lower the output voltage. In addition, the controller 10 actuates the switching means to thereby connect selectively any of the winding sets 1U-1V-1W, 2U-2V-2W and 3U-3V-3W of the high-tension winding 54 in parallel and/or in series, or leave unconnected from each other to regulate the high-tension winding to produce a desired constant d-c voltage. The main windings 14 for the high-tension winding 54 are each divided into two halves. At low speed in rpm of the rotor, the output developed with the overall windings 14 is supplied to a heavy load side of a high-tension power source 25 to energize the actuator 9, thereby moving the annular member 7 so as to yield the desired constant direct-voltage, for example 100V. In contrast, when the rpm of the generator or the rotor 3 rises to the degree to which the angular control of the annular member 7 is impossible of the realization of flux control, the

switching means are energized to reduce the number of turns in the main windings, thereby yielding the desired constant direct-voltage, for example 100V.--

Paragraph spanning pages 54 and 55:

-- The actuator 9 is composed of, for example a solenoid-operated valve having a connecting rod 31 fixed to any axial end of the annular member 7. The controller 10 moves the connecting rod 31 of the solenoid-operated valve to rotate in increments the annular member 7 to any angular position selected out of more than one position of the annular member 7 by the use of any position sensor. With the actuator 9 in which the connecting rod 31 is fixed at opposing ends thereof to the solenoid-operated valve and any axial end of the annular member 7, controlling a current in a coil of the solenoid-operated valve causes the connecting rod 31 to move in and out, thereby rotating the annular member 7 in increments, either clockwise or counterclockwise, so that the magnetic flux permeable piece 17 and nonmagnetic piece 18 are displaced in angular position with respect to the associated tooth 20 in the stator 4. Thus, the actuator 9 will vary the voltage loaded on the solenoid-operated valve, for example depending on the position of the connecting rod 31 monitored by the position sensor. With the solenoid-operated valve being applied with a large voltage, for example, the annular

member 7 is driven to move circumferentially. As the voltage is reduced, the annular member 7 will come to rest at the desired position. As an alternative, the annular member 7 is provided with for example a return spring to make it easy to keep the annular member 7 at any desired position. Moreover, the annular member 7 may be provided at axially opposing ends thereof with outer rings, each to each end, to keep the magnetic force against leaking out from the axially opposing ends.--

Paragraph spanning pages 59 and 60:

-- With the magnetic flux control means in which the annular member 7 is moved circumferentially by means of the actuator 9 energized in accordance with instructions issued out of the controller 10, the annular member 7 is allowed to move into any of more than one angular position; a first position where any magnetic flux permeable piece 17 of the annular member 7 comes in alignment with any slot 22 in the stator core 15 as shown in FIGS. 4 and 6(I) and a second position where any magnetic flux permeable piece 17 of the annular member 7 comes in alignment with any tooth 20 in the stator core 15 as shown in FIGS. 5 and 6(II). Whenever the annular member comes into the position as shown in FIGS. 5 and 6(II), where any magnetic flux permeable piece 17 of the annular member 7 is placed in radial alignment with any tooth

20 in the stator core 15 while any nonmagnetic pieces 18 of the annular member 7 comes into radial alignment with any slot 22 in the stator core 15, the magnetic force coming from the permanent-magnet member 5 passes through the magnetic flux permeable pieces 17 of the annular member 7 and then the teeth 20 in the stator core 15 to drive the rotor 3. As opposed to the above, whenever annular member comes into the position as shown in FIGS. 4 and 6(I), where any magnetic flux permeable piece 17 of the annular member 7 is placed between any two adjacent teeth 20 in the stator core 15, with bridging any clearance between the two adjacent teeth 20, the magnetic flux coming from the permanent-magnet member 5 is restricted.--

Paragraph spanning pages 60 and 61:

-- Both the magnetic flux permeable piece 17 and the nonmagnetic piece 18 of the annular member 7 may be determined in their circumferential size with respect to the clearance in the stator core 15, for example in such a relation that the magnetic flux coming from the permanent-magnet member 5 and entering the teeth 20 in the stator core 15 through the nonmagnetic pieces 18 of the annular member 7 is almost equivalent in flux density with the magnetic flux coming from the permanent-magnet member 5 and entering the teeth 20 in the stator core 15 through the magnetic flux permeable pieces 17. Thus, when the actuator 9 moves the annular member 7

relatively to the stator 4 into any angular position where any magnetic flux permeable piece 17 of the annular member 7 is brought into alignment with any associated tooth 20 in the stator core 15, the magnetic force coming from the permanent-magnet member 5 and entering the teeth 20 in the stator core 15 through the magnetic flux permeable pieces 17 of the annular member 7 of the annular member 7 is allowed to shift circumferentially with uniformity. Once the rotor 3 is running, the annular member 7 is kept in the position where any magnetic flux permeable pieces piece 17 comes into a position corresponding to any associated tooth 20 in the stator core 15 as seen from FIGS. 4 and 6(II). In contrast, when the rotor 3 comes to rest, any magnetic flux permeable piece 17 of the annular member 7 is placed facing with any associated clearance, or slot 22, between any adjacent teeth 20 in the stator core 15 so that the magnetic flux coming from the permanent-magnet member 5 and entering the teeth 20 in the stator core 15 is restricted to pass circumferentially of the annular member 7 with uniform distribution.--

Paragraph spanning pages 63 and 64:

-- The magnetic flux control means according to the second embodiment, as shown in particular in FIG. 10, is characterized by the distinctive form in the annular member 7 and corresponding shape of the tooth 20a in the stator core

15a. The annular member 7a is comprised of more than one magnetic flux permeable piece 17a of rectangle in cross section arranged circumferentially in the form of cylinder with nonmagnetic pieces 18a being each interposed between any two adjacent magnetic flux permeable pieces 17a. Any magnetic flux permeable piece 17a has a circumferential width  $t_2$  made less than a circumferential width  $t_1$  of any slot 22a in the stator core 15a of the stator 4a:  $t_1 > t_2$ . Moreover, the magnetic flux permeable piece 17a is chamfered off at radially outside corners, called first chamfer 24, of the rectangle viewed in cross section. Thus, when the annular member 7 is placed at the angular position where any magnetic flux permeable piece 17a comes into radial alignment with any slot 22a, there is provided any preselected clearances  $t_3$  and  $t_4$ , called first clearance between any first chamfer 24 and any associated radially inside corner of the tooth 20a in the stator core 15a. The annular member 7a, when being moved circumferentially by the driving means of the actuator 9a, is controlled in a manner to make any one  $t_3$  of the clearances  $t_3$  and  $t_4$  ahead of any magnetic flux permeable pieces 17a almost equal in amount to another clearance  $t_4$  behind the magnetic flux permeable piece 17a:  $t_3 = t_4$ . The tooth 20a in the stator core 15a is also chamfered off at its tooth tip corners called second chamfer 24a.--

Paragraph spanning pages 64 and 65:

-- The annular member 7a fits in the stator 4a for rotation relative to the stator 4a with the outside periphery thereof keeping the close sliding contact with the tooth tips of the teeth 20a in the stator 4a. Thus, the actuator 9a forces the annular member 7a to rotate in increments with respect to the stator 4a, changing the angular position of the annular member 7a relatively to the stator 4a to vary the magnetic flux passing through the tooth 20a, eventually controlling the produced electric power. The clearances  $t_3$ ,  $t_4$  between any chamfered chamfers 24 on the magnetic flux permeable piece 17a in the annular member 7a and the associated confronting chamfer 24a on the tooth 20a in the stator core 15a are varied in traverse distance as the actuator 9a moves the magnetic flux permeable piece 17a in increments with respect to the opposing tooth 20a in the stator core 15a.--

Paragraph spanning pages 65 and 66:

-- The annular member 7a, for example as shown in FIG. 11, may be comprised of magnetic flux permeable rings 11a and magnetic flux permeable/nonmagnetic sets 12a, which are arranged in a manner to alternate lengthwise each other. The magnetic flux permeable rings are each made of magnetic flux permeable materials laminated circumferentially in a rich

density while the magnetic flux permeable/nonmagnetic sets 12a are each composed of arced magnetic flux permeable pieces 17a arranged circumferentially apart from each other with nonmagnetic pieces 18a being each interposed between any adjacent magnetic flux permeable pieces 17a. The nonmagnetic piece 18a may be either replaced with air or made of any reinforcing member of aluminum, resinous material and so on. The magnetic flux permeable pieces 17a are each roughly equal in axial length with the tooth 20a in the stator core 4a and also the number of the magnetic flux permeable pieces 17a is equal the number of the stator teeth 20a. Moreover, the magnetic flux permeable rings 11a are each made of silicon-steel plates and ring members laminated alternately and jointed together in the axial direction of the annular member 7a. As an alternative, the magnetic flux permeable/nonmagnetic set 12a in the annular member 7a may be made in a construction in which a magnetic flux permeable steel ring is provided with windows positioned at equal intervals around the circular surface, and nonmagnetic reinforcing materials fit in the windows.--

Paragraph spanning pages 66 and 67:

-- The actuator 9a, for example as shown in FIG. 11, includes a solenoid-operated valve 29a having a connecting rod 31a fixed to any axial end of the annular member 7a. A

controller 10a moves the connecting rod 31a of the solenoid-operated valve 29a to rotate in increments the annular member 7a to any angular position selected out of more than one position of the annular member 7 by the use of a position sensor 26a. With the actuator 9a in which the connecting rod 31a is connected at opposing ends thereof to the solenoid-operated valve 29a and any axial end of the annular member 7a, controlling a current in a coil of the solenoid-operated valve 29a causes the connecting rod 31a to move in and out, thereby rotating the annular member 7 in increments, either clockwise or counterclockwise, so that the magnetic flux permeable piece 17a and nonmagnetic piece 18a are displaced in angular position with respect to the associated tooth 20a in the stator 4a. Thus, the actuator 9a will vary the voltage loaded on the solenoid-operated valve 29a, for example depending on the position of the connecting rod 31a monitored by the position sensor 26a. With the solenoid-operated valve 29a being applied with a large voltage, for example, the annular member 7a is driven to move circumferentially. As the voltage is reduced, the annular member 7a will come to rest at the desired position. Moreover, the annular member 7a is provided with a return spring 44a to make it easy to keep the annular member 7a at any desired position. Besides, the annular member 7a is provided at axially opposing ends thereof with

outer rings 27a, each to each end, to keep the magnetic force against leaking out from the axially opposing ends.--

Paragraph spanning pages 69 and 70:

-- As seen from FIG. 10, both the magnetic flux permeable pieces 17a and the teeth 20a in the magnetic flux control means are chamfered at 24 and 24a to help ensuring for generating a constant output voltage, for example the output voltage of 100V. With the prior permanent-magnet generator in which there is no provision of the annular member for flux control between the rotor 3a and the stator 4a, the output voltage rises along a curve D in FIG. 14 to the extent to which the voltage control comes impossible as the rotor 3a is driven with high speed in rpm. In contrast, the magnetic flux control means having the annular member 7a controllable in angular position succeed in lowering the output voltage to any desired constant voltage as shown by downward arrows. With other prior motor-generator having the annular control member arranged between the rotor and the stator, for example disclosed in Published Unexamined Patent Application in Japan No.2000-261 988, it has been possible to produce the output voltage controlled as shown in Fig. 14 with curves B and C. Nevertheless, since the output voltage increases gradually according to the increase of the rotor speed in rpm, it has been very tough to ensure the desired voltage kept constant

irrespective of the variation in the rotor speed. Even in an event where the number of turns in the winding is small as shown by a curve E, moreover, any angular movement of the annular member 7a realizes the control of the produced voltage to any desired output voltage as shown by downward arrows when the speed in rpm of the rotor 3a is elevated.--

Paragraph spanning pages 70 and 71:

-- With the motor-generator constructed as stated just earlier, the controller 10a issues any instruction to get the actuator 9a working to move the annular member 7a to either any angular position where any magnetic flux permeable piece 17a comes in alignment with the confronting slot 22a of the stator core 15a at center radial lines of their circumferential widths or any other position where any magnetic flux permeable piece 17a of the annular member 7a comes in alignment with the confronting tooth 20a of the stator core 15a at center radial lines of their circumferential widths. When the annular member 7a is brought into an angular position shown in FIG. 8, where any magnetic flux permeable piece 17a of the annular member 7a comes in alignment with the associated tooth 20a of the stator core 15a at center radial lines of their circumferential widths while any nonmagnetic piece 18a of the annular member 7a is in alignment with the associated slot 22a in the stator core 15a

on their widthwise center radial lines, the magnetic force is allowed to pass coming from and entering the permanent-magnet members 5a through the magnetic flux permeable pieces 17a of the annular member 7a and the teeth 20a in the stator core 15a, thereby rotating the rotor 3a. In contrast, when the annular member 7a moves to another position shown in FIG. 9, where any magnetic flux permeable piece 17a of the annular member 7a is placed between any two adjacent teeth 20a in the stator core 15a or in circumferential alignment with any clearance between the adjacent teeth 20a in the stator core 15a, the magnetic flux passing through there is subject to restriction.--

Paragraph spanning pages 72 and 73:

-- Both the permeable piece 17a and the nonmagnetic piece 18a are each determined in circumferential or widthwise size with respect to the clearance in the stator core 15a in such a manner that the magnetic flux coming from the permanent-magnet member 5a and entering the teeth 20a in the stator core 15a through any nonmagnetic piece 18a of the annular member 7a is roughly equivalent in magnetic flux density to the magnetic flux coming from the permanent-magnet member 5a and entering the teeth 20a in the stator core 15a through any magnetic flux permeable piece 7a of the annular member 7a. Thus, when the actuator 9a urges the annular

member 7a to move into any angular position where any magnetic flux permeable piece 17a of the annular member 7a comes in alignment with any associated tooth 20a in the stator core 15a, the magnetic force coming from the permanent-magnet member 5a and entering the teeth 20a in the stator core 15a through the magnetic flux permeable pieces 17a of the annular member 7a may shift circumferentially with uniformity. In the motor-generator having the magnetic flux control means constructed as stated above, once the rotor 3a is running, the annular member 7a is kept in the position shown in FIG. 8, where any magnetic flux permeable pieces piece 17a comes into radial opposition to any associated tooth 20a in the stator core 15a. In contrast, when the rotor 3 comes to rest, any magnetic flux permeable piece 17a of the annular member 7a is placed as shown in FIG. 9, with any clearances  $t_3$ ,  $t_4$  remaining between the widthwise ends of the magnetic flux permeable piece 17a and the adjacent teeth 20a in the stator core 15a, so that the magnetic flux coming from the permanent-magnet member 5a and entering the teeth 20a in the stator core 15 is restricted to pass circumferentially of the annular member 7 with uniform distribution.--

Paragraph spanning pages 81 and 82:

--An annular member 7c in the fourth embodiment shown in FIGS. 23 and 25 is comprised of first magnetic flux

permeable parts 11c in which magnetic flux permeable materials are densely laminated in the form of a circle, and second magnetic flux permeable parts 12c in which arced magnetic flux permeable chips 17c are arranged circularly in a manner spaced apart from each other to leave a window open between any two adjacent magnetic flux permeable chips 17c. The first and second magnetic flux permeable parts 11c, 12c unlike in density are arranged alternately along the axial direction of the motor-generator. Nonmagnetic chips 18c of nonmagnetic material such as aluminum and so on are charged in the windows between the adjacent arced magnetic flux permeable chips 17c in the second magnetic flux permeable parts 12c, or density-lean magnetic flux permeable parts, to reinforce in stiffness the density-lean magnetic flux permeable parts. Moreover, the magnetic flux permeable chip 17c has a circumferential width that is roughly equivalent to a length spanning across a tooth 20c in the stator 4c, while the number of the magnetic flux permeable chips per one density-lean magnetic flux permeable part 12c is equal to the number of the teeth 20c in the stator 4c. That is to say, the permeable chip 17c has a circumferential width that is roughly equivalent to a length spanning across a tooth 20c in the stator 4c, whereas the nonmagnetic chip 18c is either identical to or somewhat less in circumferential width than the tooth 20c in the stator 4c.

The number of the nonmagnetic chips per one density-lean magnetic flux permeable part 12c is also equal to the number of the teeth 20c in the stator 4c.--

Paragraph spanning pages 82 and 83:

-- As an alternative, the density-lean magnetic flux permeable part 12c in the annular member 7c, as illustrated partly in FIG. 25, is formed in a construction in which annular magnetic flux permeable steel sheets are overlaid axially one on the other, with leaving windows 40c positioned at regular intervals around the curved surface of the annular member 7, the windows 40c being filled with nonmagnetic chips 18c of nonmagnetic material such as aluminum and so on to reinforce in stiffness the density-lean magnetic flux permeable part 12c. The first magnetic flux permeable parts 11c, or density-rich magnetic flux permeable parts, of the annular member 7c are built up of laminations juxtaposed axially, each of which is made of an annular disc and a silicon steel sheet laid one on top of another.--

Paragraph spanning pages 83-85:

-- As an alternative, the actuator 9c as shown in FIG. 26 may be composed of a solenoid-operated valve 29c having a connecting rod 31c fixed to any axial end of an annular member 7Ac. The controller 10c moves the connecting

rod 31 of the solenoid-operated valve 29c to rotate in increments the annular member 7Ac to any angular position selected out of more than one position of the annular member 7 by the action of the position sensor 26c. Most of components and parts of the annular member 7Ac shown in FIG. 26 are the same as previously described in the annular member 7c in FIG. 25. To that extent, the components and parts have been given the same reference characters affixed with "A"; density-rich magnetic flux permeable parts 11Ac, density-lean magnetic flux permeable parts 12Ac, magnetic flux permeable chips 17Ac and nonmagnetic reinforcing chips 18Ac, so that the previous description will be applicable. With the actuator 9c in FIG. 26 in which the connecting rod 31c is connected at opposing ends thereof to the solenoid-operated valve 29c and any axial end of the annular member 7Ac, controlling a current in a coil of the solenoid-operated valve 29c causes the connecting rod 31c to move in and out, thereby rotating the annular member 7Ac in increments, either clockwise or counterclockwise, so that the magnetic flux permeable chips 17Ac and nonmagnetic chips 18Ac are displaced in angular position with respect to the associated tooth 20c in the stator 4c. Thus, the actuator 9c will vary the voltage loaded on the solenoid-operated valve 29c, for example depending on the position of the connecting rod 31c monitored by the position sensor 26c. With the

solenoid-operated valve 29c being applied with a large voltage, for example, the annular member 7Ac is driven to move circumferentially. As the voltage is reduced, the annular member 7Ac will come to rest at the desired position. Moreover, the annular member 7Ac is provided at axially opposing ends thereof with outer rings 27c, each to each end, to keep the magnetic force against leaking out from the axially opposing ends.--

Paragraph spanning pages 88 and 89:

-- With magnetic flux control means according to the fourth embodiment constructed as stated earlier, in which the annular member 7c is moved circumferentially by means of the actuator 9c energized in accordance with instructions issued out of the controller 10c, the annular member 7c is allowed to move in increments into any of more than one angular positions; a first position where any magnetic flux permeable chip 17c of the annular member 7c comes in alignment with any slot 22c in the stator core 15 on their centers of circumferential width and a second position where any magnetic flux permeable chips 17c of the annular member 7c comes in alignment with any tooth 20 in the stator core 15a. Whenever the annular member 7c comes into the position as shown in FIG. 23, where any magnetic flux permeable chip 17c of the annular member 7c is placed in alignment with any tooth 20c in the

stator core 15c while any nonmagnetic chip 18c of the annular member 7c comes into alignment with any slot 22c in the stator core 15c, the magnetic force coming from the permanent-magnet member 5c passes through the magnetic flux permeable chips 17c of the annular member 7c and then the teeth 20c in the stator core 15c to drive the rotor 3c. As opposed to the above, whenever annular member 7c comes into the position as shown in FIGS. 24, where any magnetic flux permeable chips 17c of the annular member 7c is placed between any two adjacent teeth 20c in the stator core 15, with bridging any clearance between the two adjacent teeth 20c, the magnetic flux coming from the permanent-magnet member 5c is restricted.--

Paragraph spanning pages 89 and 90:

-- Both the magnetic flux permeable chip 17c and the nonmagnetic piece 18c of the annular member 7c may be determined in their circumferential size with respect to the clearance between any adjacent teeth 20c in the stator core 15c, for example in such a relation that the magnetic flux coming from the permanent-magnet member 5c and entering the teeth 20c in the stator core 15c through the nonmagnetic chips 18c of the annular member 7c is almost equivalent in flux density with the magnetic flux coming from the permanent-magnet member 5c and entering the teeth 20c in the stator core 15c through the magnetic flux permeable chips 18c. Thus, when

the actuator 9c moves the annular member 7c relatively to the stator core 15c into any angular position where any magnetic flux permeable chip 17c of the annular member 7c bridges across any clearance between any two adjacent teeth 20c in the stator core 15c, the magnetic force coming from the permanent-magnet member 5c and entering the teeth 20c through the magnetic flux permeable chips 17c of the annular member 7c is allowed to shift circumferentially with uniformity.--

Page 90, first paragraph:

-- Once the rotor 3c is running, the annular member 7c is kept in the position where any magnetic flux permeable chip 17c of the annular member 7c comes into opposition to any associated tooth 20c in the stator core 15c as seen from FIG.

23. In contrast, when the rotor 3c comes to rest, any magnetic flux permeable chip 17c of the annular member 7c is placed bridging across any associated clearance between any adjacent teeth 20c in the stator core 15c, as shown in FIG.

24, so that the magnetic flux coming from the permanent-magnet member 5c and entering the teeth 20c in the stator core 15c is restricted to pass circumferentially of the annular member 7c with uniform distribution.--